

Notice of Allowability

Application No.

10/816,236

Examiner

William C. Doerrler

Applicant(s)

GRENFELL, CONRAD Q.

Art Unit

3744

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to the 12-27-after final amendment.
2. ☒ The allowed claim(s) is/are 1-9 and 11-20.
3. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 - a) ☐ All b) ☐ Some* c) ☐ None of the:
 1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).


* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
 5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
 - (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
 - 1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
 - (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.
- Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO-1449 or PTO/SB/08), Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application (PTO-152)
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____
7. ☐ Examiner's Amendment/Comment
8. ☐ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____


William C Doerrler
Primary Examiner
Art Unit: 3744

In the Claims:

Kindly cancel Claims 10, 21 and 22.

Please amend the claims as indicated.

1. (Currently Amended) A gas pressurization system comprising:
 - a gas inlet valve configured to receive an inlet gas stream;
 - a clean-up system coupled to said gas inlet valve, said clean-up system configured to remove impurities from said inlet gas stream;
 - a recovery heat exchanger coupled to said clean-up system, said recovery heat exchanger configured to remove thermal energy from said inlet gas stream and cool said inlet gas stream into one of a pre-cooled gas stream and a pre-cooled liquid stream;
 - an expander coupled to said recovery heat exchanger, said expander configured to expand said pre-cooled liquid stream into a two-phase fluid;
 - a refrigeration unit coupled to said expander, said refrigeration unit configured to cool said two-phase fluid into a liquid phase fluid;
 - a buffer storage unit coupled to said refrigeration unit, said buffer storage unit configured to provide a net positive suction head;
 - a pump coupled to said buffer storage unit at a pump suction, said pump having a pump discharge coupled to said recovery heat exchanger, wherein said recovery heat exchanger is configured to transfer thermal energy from said inlet gas stream to a liquid discharge from said pump discharge; and
 - an underground natural gas reservoir coupled to said pump discharge downstream of said recovery heat exchanger, wherein said underground natural gas reservoir comprises at least one of a depleted natural gas or oil field, an aquifer, and a salt cavern.

2. (Original) The gas pressurization system of claim 1 further comprising:
fluid conduit coupling between said recovery heat exchanger, said expander, said refrigeration unit, said buffer storage unit, said pump, and said recovery heat exchanger, wherein said fluid conduit comprises very low heat gain insulation.

3. (Previously Presented) The gas pressurization system of claim 2 wherein said very low heat gain insulation comprises a vacuum jacket pipe disposed over an inner pipe and a vacuum.

4. (Previously Presented) The gas pressurization system of claim 1 further comprising:
a discharge control valve between said recovery heat exchanger and said underground natural gas reservoir, said discharge control valve configured to control gas flow to said underground natural gas reservoir.

5. (Original) The gas pressurization system of claim 1 further comprising:
an energy absorbing device coupled to said expander, wherein said energy absorbing device converts mechanical energy from said expander for use by said refrigeration unit.

6. (Original) The gas pressurization system of claim 5 wherein said energy absorbing device comprises at least one of an electrical generator, a gas compressor and a hydraulic pump.

7. (Original) The gas pressurization system of claim 1 wherein said expander comprises at least one of a turbo-expander and a Joule-Thomson valve.

8. (Original) The gas pressurization system of claim 1, wherein said refrigeration unit is configured to liquefy said vapor to one of a saturated and sub-cooled thermodynamic condition.

9. (Original) The gas pressurization system of claim 1 wherein said pump comprises at least one of a submerged multistage centrifugal pump and a positive displacement pump and a plurality of incompressible fluid pumps.

10. (Canceled).

11. (Currently Amended) A gas pressurization system comprising:
a gas inlet valve, configured to receive an inlet natural gas stream;
a clean-up system coupled to said gas inlet valve, said clean-up system configured to remove impurities from said inlet natural gas stream;
a recovery heat exchanger coupled to said clean-up system, said recovery heat exchanger configured to remove thermal energy from said inlet natural gas stream and cool said inlet natural gas stream to one of a pre-cooled natural gas stream and a pre-cooled liquefied natural gas stream;
an expander coupled to said recovery heat exchanger, said expander configured to expand said pre-cooled liquefied natural gas stream into a two phase fluid;
a refrigeration unit coupled to said expander, said refrigeration unit configured to cool said two phase fluid to a liquid phase;
a buffer storage unit coupled to said refrigeration unit, said buffer storage unit configured to provide a net positive suction head;
a pump coupled to said buffer storage unit at a pump suction and said pump having a pump discharge coupled to said recovery heat exchanger, wherein said

recovery heat exchanger is configured to transfer thermal energy from said inlet gas stream to a liquefied natural gas discharge from said pump discharge; and

an underground natural gas reservoir coupled to said pump discharge downstream of said recovery heat exchanger, wherein said underground natural gas reservoir comprises at least one of a depleted natural gas or oil field, an aquifer, and a salt cavern.

12. (Original) The gas pressurization system of claim 11, wherein said clean-up system is configured to remove impurities selected from the group consisting of water, carbon dioxide, C6+, heavy hydrocarbons, and sulfur compounds.

13. (Original) The gas pressurization system of claim 11 wherein said expander comprises at least one of a turbo-expander and a Joule-Thomson valve.

14. (Original) The gas pressurization system of claim 11 further comprising:
an energy absorbing device coupled to said expander, wherein said energy absorbing device converts mechanical energy from said expander for use by said refrigeration unit, wherein said energy absorbing device comprises at least one of an electrical generator, a gas compressor and a hydraulic pump.

15. (Original) The gas pressurization system of claim 14 further comprising:
a gaseous natural gas stream coupled to said buffer storage unit and configured to provide at least one of a fuel for said refrigeration unit and an additional cooling fluid in said recovery heat exchanger.

16. (Original) The gas pressurization system of claim 11 wherein said refrigeration unit comprises at least one of a cascade refrigeration unit, a closed loop refrigeration unit and a plurality of refrigeration units.

17. (Currently Amended) A method of pressurizing a gas comprising:
flowing a gas through a gas inlet valve;
removing impurities from said gas;
precooling said gas in a recovery heat exchanger into one of a gas phase and a liquid phase;
expanding said liquid phase to a two-phase fluid through an expander;
cooling said two-phase fluid to one of a saturated and a sub-cooled liquid;
storing said saturated sub-cooled liquid in a buffer storage unit;
maintaining a net positive suction head in said saturated liquid and said sub-cooled liquid;
pumping said saturated liquid and said sub-cooled liquid with a pump through said recovery heat exchanger;
exchanging thermal energy from said gas to said saturated liquid and said sub-cooled liquid in said recovery heat exchanger; and
storing a high pressure natural gas in an underground natural gas reservoir, wherein said underground natural gas reservoir comprises at least one of a depleted natural gas or oil field, an aquifer, and a salt cavern.

18. (Original) The method of claim 17 wherein said expanding said liquid phase to a two phase fluid includes at least one of expansion through a turbo-expander and expansion through a Joule-Thomson valve.

19. (Original) The method of claim 17 further comprising:

absorbing mechanical energy from said expander with an energy absorbing device, said energy absorbing device including at least one of an electrical generator, a gas compressor and a hydraulic pump.

20. (Original) The method of claim 17 wherein said gas is natural gas and said liquid is liquefied natural gas.

21. (Canceled).

22. (Canceled).